Attachment 2

Vermont Yankee Nuclear Power Station

Proposed Technical Specification Change No. 263 – Supplement No. 9

Extended Power Uprate

Revised Containment Overpressure Envelope

VYC-0808, Revision 6, CCN 06

Total number of pages in Attachment 2 (excluding this cover sheet) is 22.



VYC-0808, Revision 6, CCN 06

ENN-DC-126, Rev 4

MINOR CALCULATION CHANGE

PAGE 1 OF 14

ENN-DC-126, ATTACHMENT 9.8

MINOR CALCULATION CHANGE FORM

MINOR CALCULATION CHANGE FORM (Tracked via DRN in MERLIN)

Calculation No.: VY						
Calculation Title: Core S Suction Head Margin For Transient Without Scrat	Revision: <u>6</u> Indicate Status of					
MERLIN DRN No. or	Minor Calculation Change N	lo.: <u>06</u>		nor Calc		
Modification No./Tas	k No./ER No. <u>VYDC-2003-00</u>	08.		ange; end; ¬A		
Computer Code Use If "Yes", Code:	d 🗍 Yes 🖾 No.					
1 Purpose of Chang	e:	Incorporate GE-VYNPS-A	AEP-	346R1		
2 SSC affected:		See attached VYAPF00	17.0	7		
3 Design Input Doci Calculation:	uments not used in parent	See attached VYAPF00	17.0	7		
4 Drawings/Procedu Documents affected	ures/ Calculations / other	See attached VYAPF00	17.0	7		
5 Description of Ch	ange:	See attached descripti	ption			
6 Impact on existing	g calculation conclusion:	Revised containment over long term LOCA using 10	rpressure envelope for 00% Spray Efficiency			
7 impact on DBD's,	UFSAR, Technical Specifica	itions:	See attached VYAPF0017.07			
8. The existing calcu checklist. (See Rema	ulation does/does not (circle	one) have a calculation	ı ve	rificatio	1	
Remarks: This ENN-I 0017 did not have a "ch	DC-126 MCC is to a VY design vecklist", instead design verificat	verified calculation prepared tion was documented on for	d und m V	ier AP-00 YAPF001	17. AP- 7.04	
not be used unl	chnical Specifications need to be less it is an editorial change to the on Change Forms do not change	UFSAR or Technical Spec	ificat	lons.		
Prepared by:	E. P. O'Brien Pripusi			Date:	7/16/04	
Reviewed by: *	E.G. Lind & A. Lu	J		Date:	7/16/04	
Approved by		Date:	7/20/03			
* Where the original call verification is still valid.	culation was design verified, the	eviewer signature confirms	the !	atest desi	gn	
verincation is still valid.	This IS a Quality	y Record -				

Entermy		VYC-0808, Revision 6, CCN 06	
≈ Entergy	ENN-DC-126, Rev 4	MINOR CALCULATION CHANGE	PAGE 2 OF 14

ENN-DC-126, Rev. 4, ATTACHMENT 9.8

MINOR CALCULATION CHANGE FORM

5. Description of Change

The NPSH evaluation of the RHR and CS pumps is performed, using the same methodology as CCN04 (Ref. 11) for short term DBA-Loss of Coolant Accident (LOCA) case and CCN05 (Ref. 12) for long term DBA-Loss of Coolant Accident (LOCA) case. This CCN uses the EPU suppression pool temperature/pressure data supplied in Reference 1. Note – all References contained in AP0017.07 (Attachment B)

Reason for Change:

This CCN provides additional results regarding the Residual Heat Removal (RHR) and Core Spray (CS) Pump NPSH resulting from the Extended Power Uprate (EPU), which was initially evaluated in CCN04 and subsequently in CCN05.

Specifically, this CCN06 updates the short-term and long-term post LOCA results based on revised containment temperature and pressure profiles provided in Reference 1. The revised containment profiles reflect that the Containment Spray Thermal Mixing Efficiency used to develop the Reference 1 input was increased to 100%. This increase in spray efficiency resulted in a slight reduction to the pressure profile. The containment spray thermal mixing efficiency utilized in CCN 5 was based on the containment air to steam mass ratio.

CCN06 remains based upon: (1) The long-term post LOCA time of 200,000 seconds, beyond which overpressure is no longer being required, and (2) the containment leakage of 1.5 weight percent per day, to reflect the recently submitted Alternate Source Term (AST) License Amendment Request (Ref: 5, ERC-2004-024)

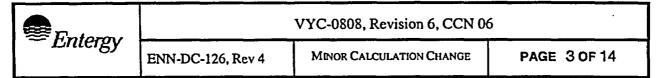


Table of Contents

Cover	Page	.1
	ption of Change	
TABI	E OF CONTENTS	. 3
1.0	OBJECTIVE	. 4
2.0	METHODOLOGY	٠, د
3.0	ASSUMPTIONS	, 4
4.0	ANALYSIS	٠.
4.1		
4	.1.1 Evaluation	
4.2		
	2.1 Evaluation	
5.0	SUMMARY OF RESULTS	.9
5.1	LOCA - SHORT TERM (0-600 SEC):	.9
5.2	LOCA - Long Term (>600 sec):	.9
6.0	CONCLUSIONS	. 9
	E 4.1 LOCA – SHORT TERM (1.5 WT. % CONTAINMENT LEAKAGE & 100% SPRAY	l
	E 4.2 LOCA – LONG TERM (1.5 WT. % CONTAINMENT LEAKAGE & 100% SPRAY	[]
	RE 4.2 LOCA – LONG TERM (1.5 WT. % CONTAINMENT LEAKAGE & 100% SPRAY CIENCY)	14
Note:	Figure 4.1 is not contained in this CCN.	
Attac	hment A Excel Verification Sample Calculation6 pages	
Attac	hment B · VY Calculation Database Input Form (VY APF0017.07)2 pages	

TOTAL PAGES: 22

Entermy		VYC-0808, Revision 6, CCN 06	j
≈ Entergy	ENN-DC-126, Rev 4	MINOR CALCULATION CHANGE	PAGE 4 OF 14

1.0 Objective

The objective of this CCN is to update the CCN05 (Ref. 12) post LOCA Extended Power Uprate (EPU) evaluation of the adequacy of the available NPSH for the Residual Heat Removal (RHR) and Core Spray (CS) pumps. This includes identification of any change in the amount and duration of suppression pool (torus) overpressure required to maintain adequate NPSH.

Specifically, this CCN06 updates the post LOCA results based on revised containment temperature and pressure profiles provided in Reference 1. The revised containment profiles reflect that the Spray Efficiency used to develop the Reference 1 input is 100%, which resulted in a slight reduction to the pressure profile from CCN05.Additionally, Reference 1 provided revised short-term LOCA data. Therefore, Section 4.1 of CCN04 to VYC-0808 Rev 6 (Ref. 11) is updated to include this data, though the results will be shown to remain unchanged.

2.0 Methodology

General

The methodology for determining the NPSH available (NPSHa) for a given event and temperature is the same as that developed in VYC-0808 Rev 6 and presented in Table 1 of that calculation (Ref: 4). The NPSH required (NPSHr) is also per VYC-0808 Rev 6 and is discussed in detail in Section 4.0 of this CCN. The methodology for determining the pump suction strainer head loss during a LOCA, and the time dependent profile for required overpressure is the same as that developed in CCN04.

3.0 Assumptions

1. None made

4.0 Analysis

As stated in Section 2.0, the methodology for determining the NPSHa is the same as that developed in VYC-0808 Rev 6 and presented in Table 1 of that calculation (Ref: 4). The following terms are used in the evaluation.

NPSHa (ft) = net positive suction head available without overpressure credit (14.7-Pg)(144vf)+Z-hf-hs-hd

where:

Z (ft) = suction elevation head hf (ft) = suction line losses hs (ft) = clean strainer losses hd (ft) = strainer debris losses

Pg (psia) = vapor pressure @ torus temperature

vf (ft^3/lb) = specific volume @ torus temperature and pressure

Pg and vf are obtained from ASME Steam Tables 1967 Formulation (Ref: 7)

Entergy		VYC-0808, Revision 6, CCN 06	
Entergy	ENN-DC-126, Rev 4	MINOR CALCULATION CHANGE	PAGE 5 OF 14

NPSHr (ft) = net positive suction head required.

It should be noted that the NPSH required data provided by the pump vendor, as documented in Figures 2.1-1 and 2.2-1 of Attachment 3 to calculation VYC-0808, is actually Allowable Operating Periods @ NPSHa Specified. Allowable hours of operation at specified NPSHa values are identified for a range of flows. For this CCN, the NPSHa specified in these Figures is taken as the NPSHr at a given operating time.

Q (gpm) = pump flow rate

OPR (psig) = Overpressure Required (NPSHr - NPSHa)/(144*Vf)

For those profile points where there is inadequate NPSH, when considering the suppression pool pressure to be atmospheric (14.7 psia), OPR is the amount of suppression pool pressure required to make NPSHa (ft) equal to NPSHr (ft).

OPA (psig)- Overpressure Available

The suppression pool pressure available, above atmospheric, for a given event and time.

OPC (psig)- Overpressure Credit Taken

The overpressure credited in the evaluation of NPSH. Engineering judgement is used to select the credit to be greater than the OPR, by a reasonable amount, and less than the OPA.

Detailed discussion of the above terms is provided in the subsections that follow.

Entermy		VYC-0808, Revision 6, CCN 06	5
≈ Entergy	ENN-DC-126, Rev 4	Minor Calculation Change	PAGE 6 OF 14

4.1 LOCA - Short Term

The temperature and pressure (T/P) profile for the suppression pool during a LOCA is developed in GE-VYNPS-AEP-346R1 (Ref: 1). The short term data is provided from 0-600 seconds.

The evaluation of NPSH is documented in Table 4.1 using the peak pool temperature of 165.1°F which occurs at 600 seconds with a corresponding pool pressure of 17.64 psia. The peak temperature results in the largest vapor pressure and lowest NPSHa. Note that the temperature at lowest pool pressure is 161.2°F / 17.40psia. At this temperature the gain in vapor pressure more than offsets the reduction in pool pressure, therefore the 165.1°F case governs. The details of the evaluation are presented at the top of the Table followed by a matrix of the NPSH results for CS and RHR. Further discussion of selected terms is presented below.

Suction Elevation Head, Z

The values of Z for RHR and CS (12.30' and 12.47'respectively) as calculated in Section 3.5 of VYC-0808 are conservatively used in this evaluation. The suction elevation head is based on the water elevation in the torus. The EPU suppression pool water volume is slightly larger than the existing value used in VYC-0808, which would result in a slight increase in water elevation, and therefore Z.

A water volume comparison at maximum pool temperature is provided below:

Pre-EPU EPU

Ref: (VYC-0808 Rev 6 Section 3.5) (GE-VYNPS-AEP-346R1)

Short Term 76,800 cuft 79,390 cuft

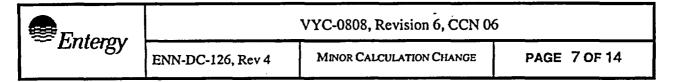
Maximum Debris Losses (hd)

1 RHR: CCN #3 (Ref: 3) calculated the limiting head loss as 0.24 ft at 181.7°F and 7400 gpm. Note that this is a slight reduction from the head loss (0.33 ft) addressed in Section 3.2 of VYC-0808 Rev 6 (Ref: 4). For conservatism, 0.33 ft at 173°F is used. (Case 1 of Tables 2 and 8 of Ref: 2).

2 RHR: The head loss is taken as .48 ft (Ref: 4) at 170°F (Case 2b of Tables 2 and 8 of Ref: 2) and 14200 gpm.

CS The head loss is conservatively taken as .32 ft (Ref: 4) at 173°F (Case 3d of Tables 2 and 8 of Ref: 2) and 4600 gpm.

Refer to Section 2.0 of CCN04 (Ref. 11) for application of head loss at temperatures other than those used in its calculation.



NPRHr - CS

Figure 2.2-1 of Attachment 3 to calculation VYC-0808 provides a plot of *Allowable Operating Periods* @ *NPSHa Specified* values for various flow rates. This plot shows that at 4600 gpm an allowable NPSH of 28.0 ft is acceptable between 0 and 7 hrs of operation.

NPRHr - 1 RHR

Figure 2.1-1 of Attachment 3 to calculation VYC-0808 provides a plot of Allowable Operating Periods @ NPSHa Specified values for various flow rates. This plot shows that at 7400 gpm an allowable NPSH of 23.8 ft is acceptable between 0 and 7 hrs of operation.

NPRHr - 2 RHR

With two RHR pumps operating at a total flow of 14,200 gpm this yields a flow of 7100 gpm per pump.

Also per Figure 2.1-1, the plot shows that at between 0 and 7 hrs of operation, an allowable NPSH of 23.5 ft is acceptable at 7000 gpm and 24.0 ft is acceptable at 7600 gpm.

Interpolating between plotted NPSH values of 23.5 ft @ 7000 gpm and 24.0 ft @ 7600 gpm yields 23.6 ft @ 7100 gpm.

The interpolation equation is developed as documented Section 2.2.2 of VYC-0808 Rev 6 and is 23.0+(Q-6400)/1200

4.1.1 Evaluation

As can been seen from Table 4.1, there is adequate NPSHa and overpressure is not required.

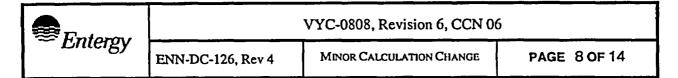
4.2 LOCA - Long Term

The temperature and pressure (T/P) profile for the suppression pool during a LOCA is developed in GE-VYNPS-AEP-346R1 (Ref: 1). The long term data is provided from 0-864,000 seconds.

The evaluation of NPSH is documented in Table 4.2 using selected T/P points representing the long term profile of the suppression pool. The details of the evaluation are presented at the top of the Table followed by a matrix of the NPSH results for the T/P profile of CS and RHR. The evaluated long term flow rates of 7400 gpm (RHR) and 3500 gpm (CS) are consistent with calculation VYC-0808 Rev 6 (Ref: 4). Further discussion of selected terms is presented below.

Suction Elevation Head, Z

The values of Z for RHR and CS (12.40' and 12.57' respectively) as calculated in Section 3.5 of VYC-0808 are conservatively used in the evaluation. The suction elevation head is based on the water elevation in the torus. The EPU suppression pool water volume is slightly larger than the existing value used in VYC-0808, which would result in a slight increase in water elevation, and therefore Z.



A water volume comparison at maximum pool temperature is provided below:

Pre-EPU EPU

Ref: (VYC-0808 Rev 6 Section 3.5) (GE-VYNPS-AEP-346R1)

Long term 77,640 cuft 79,540 cuft

Maximum Debris Losses (hd)

1 RHR: CCN #3 (Ref: 3) calculated the limiting head loss as 0.24 ft at 181.7°F and 7400 gpm. Note that this is a slight reduction from the head loss (0.33 ft) addressed in Section 3.2 of VYC-0808 Rev 6 (Ref: 4). For conservatism, 0.33 ft at 173°F is used. (Case 1 of Tables 2 and 8 of Ref: 2).

CS: Note that CCN #3 (Ref: 3) documents the up-to-date limiting head loss as 0.19 ft at 181.7°F and 3500 gpm. This is a slight reduction from the head loss (0.21 ft) addressed in Section 3.2 of VYC-0808 Rev 6 (Ref: 4). For conservatism, 0.21 ft at 173°F is used. This is based on a conservative CS flow rate of 4000 gpm. (Case 3b of Tables 2 and 8 of Ref: 2).

NPRHr - CS

Figure 2.2-1 of Attachment 3 to calculation VYC-0808 provides a plot of Allowable Operating Periods @ NPSHa Specified values for various flow rates. This plot shows that at 3500 gpm the allowable NPSH increases between 7 and 20 hrs of operation and a value of 29.6 ft is acceptable beyond 20 hrs of operation. This maximum value is conservatively used for the entire long term period (>600 sec).

NPRHr - RHR

Figure 2.1-1 of Attachment 3 to calculation VYC-0808 provides a plot of Allowable Operating Periods @ NPSHa Specified values for various flow rates. This plot shows that at 7400 gpm the allowable NPSH increases between 7 and 100 hrs of operation and a value of 31.7 ft is acceptable beyond 100 hrs of operation. This maximum value is conservatively used for the entire long term period (>600 sec).

4.2.1 Evaluation

As can been seen from Figure 4.2 the overpressure required for RHR envelopes that required for CS and the overpressure varies continuously over time. In order to facilitate reporting and presentation of the overpressure required, an enveloping, stepped, overpressure credit is overlaid on Figure 4.2. Refer to Section 4.0 for discussion on selection of overpressure credit.

Though the long term flow rates are postulated at time 600 seconds (e.g. CS throttled down from 4600gpm to 3500gpm), it is not the intent of this calculation to imply at what time throttling should commence or how much throttling is required. This is a function of the time dependent NPSHr and pool temperature. This calculation conservatively evaluates the maximum NPSHr as occurring over the entire operating period (>600 sec). The actual NPSHr is lower between 0-7 hrs and increases after 7 hrs.

Entorme		VYC-0808, Revision 6, CCN 06	5
≈ Entergy	ENN-DC-126, Rev 4	MINOR CALCULATION CHANGE	PAGE 9 OF 14

5.0 Summary of Results

NPSHa is rounded to the nearest 0.1ft and OPR, OPC, and OPA are rounded to the nearest 0.1psig.

5.1 LOCA - Short Term (0-600 sec):

NPSHa is adequate for both CS and RHR pumps without crediting overpressure. NPSHa shown below is at the peak temperature. The results remain unchanged from VYC-0808, Rev. 6, CCN04 (Ref. 11), Section 4.1, LOCA short-term results.

Pump	Total flow, gpm	NPSHr, ft	NPSHa, ft
CS	4,600	28.0	28.4
1RHR	7,400	23.8	31.1
2 RHR	14,200	23.6	28.8

5.2 **LOCA - Long Term (>600 sec):**

NPSHa is adequate for both CS and RHR pumps with an overpressure credit that varies over time, as shown in Fig. 4.2. NPSHa, OPR, OPC, OPA are shown below, at the peak temperature. The results remain unchanged from VYC-0808, Rev. 6, CCN05 (Ref. 12), LOCA long-term results, except for a slight reduction in Over Pressure Available (OPA).

Pump	Total flow, gpm	NPSHr, ft	NPSHa, ft	OPR, psig	OPC, psig	OPA, psig
CS	3,500	29.6	19.5	4.2	6.1	7.8
1RHR	7,400	31.7	19.6	5.1	6.1	7.8

6.0 Conclusions

Torus overpressure must be credited for 200,000 seconds for operating the RHR and CS pumps at EPU conditions for a long term DBA-Loss of Coolant Accident (LOCA) to achieve adequate NPSH available.

The results of this CCN will provide input to the PUSAR (Ref: 12) for the RHR and CS NPSH evaluation and will alter input to calculation VYC-1628 (Ref: 13) to address the need for crediting torus overpressure in the calculation of NPSH available. Note that calculation VYC-1628 may be superseded by GE EPU Analysis. The need for crediting torus overpressure in the RHR and CS NPSH evaluation, shall also be addressed in the SADBD (Ref: 14), UFSAR (Ref: 15), and system DBDs RHR (Ref: 16) and CS (Ref: 17).

Note that the changes to the UFSAR were originally proposed in CCN04 and CCN05 and are pending incorporation via the design change and licensing processes. This MCC simply updates the previous CCN04 and CCN05 performed under AP-0017. The UFSAR does not currently contain information on containment overpressure.

Note that use of overpressure credit must be approved by the NRC as part of EPU.

No specific 50.59 Screening/Evaluation is required for this CCN since all EPU design changes and associated 50.59 documentation will be part of VYDC-2003-008.



VYC-0808, Revision 6, CCN 06

ENN-DC-126, Rev 4

MINOR CALCULATION CHANGE

PAGE 10 OF 14

Table 4.1 LOCA - Short Term (1.5 wt. % Containment Leakage & 100% Spray Efficiency)

LOCA - Short Term

NPSHa = (14.7-Pg)(144VI)+Z-hf-hs-hdOPR = (NPSHr - NPSHaV(144°VI)

OPA = Over pressure avaliable

OPC = Over pressure credited Cross references:

Section 2.3 of VYC-0808 Rev 6 (Ref: 4) See Discussion in Section 4.0 of this CCN

Short Term Flow Rate (cpm)

1 RHR Q = 74002 RHR Q = 14200 CS Q = 4600

CS

Table of 1 calc VYC-0808 Rev 6 (Ref: 4)

Suction Line Losses (ft)

1 RHR M = 4.77E-8°Q%

2 RHR $hf = 7.84E-8^{\circ}(Q/2)^{\circ}2$ Section 3.7 of VYC-0808 Rev 6 (Ref: 4)

Clean Strainer Losses (ft)

1 RHR hs = 0.33 cs hs = 0.51 Section 3.6 of VYC-0808 Rev 6 (Ref: 4)

2 RHR hs = 1.22

Maximum Debris Losses (ft) @ >=base temperature

hd = 0.33 0173F

hd = 0.32@173F

See discussion in Section 4.1 of this CCN

Ref; 2, 3, 4 Ref: 2, 4

2 RHR hd = 0.48@170F

Maximum Debris Losses (ft) O < base temperature

 $hd = .33^{\circ}(173/1)$ 1 RHR

2 RHR $hd = .48^{\circ}(170/T)$ $hd = .32^{\circ}(173/T)$

M = 2.5E-7°Q^2

See discussion in Section 2.0 of CCN04 (Ref. 11)

where T = suppression pool temperature, F

Elevation Head (ft)

1 RHR

RHR Z = 12.3 CS Z = 12.47 See discussion in Section 4.1 of this CCN for conservatism.

NPSHr (ft)

1 RHR NPSHr = 23.8 2 RHR NPSHr = 23.6 CS NPSHr = 28.0

See discussion in Section 4.1 of this CCN

Short Term (After EPU) - Peak Torus Temperature - 1.5 wt. % Containment Leakage & 100% Spray Efficiency

Pump(s)	Time (sec)	GE Pool Temp (F)	GE Pool Pressure psia	Pg (psia)	Vf (n^3/lb)	Z (ft)	Mf (ft)	hs (ft)	hd (ft)	NPSHa (ft)	NPSHr (ft)	OPR (palg)	OPA (psig)	OPC (psig)
cs	600	165.1	17.64	5.349	0.016423	12.47	5.29	0.51_	0.34	28.44	28.00	0.00	2.94	0.00
1 RHR	600	165.1	17.64	5.349	0.016423	12.30	2.61	0.33	0.35	31.12	23.80	0.00	2.94	0.00
2 RHR	600	165.1	17.64	5.349	0.016423	12.30	3.95	1.22	0.49	28.75	23.60	0.00	2.94	0.00



VYC-0808, Revision 6, CCN 06

ENN-DC-126, Rev 4

MINOR CALCULATION CHANGE

PAGE 11 OF 14

Table 4.2 LOCA – Long Term (1.5 wt. % Containment Leakage & 100% Spray Efficiency)

LOCA - I NPSHa = OPR = OPA =	Long Term (14.7-Pg)(144Vf)+Z-hf-hs-hd Over pressure required (NPSHr Over pressure available	– NPS	Cross references: Section 2.3 of VYC-0808 Rev 6 (Ref: 4) PSHa)/(144*VI) See Discussion in Section 4.0 of this CCN				
OPC=	Over pressure credited						
Long Term 1 RHF	Flow Rate (gpm) R Q = 7400	cs	Q = 3500	Table of 1 calc VYC-0808 Rev 6 (Ref: 4)			
	Losses (ft)						
1 RHF	R hf = 4.77E-8°Q^2	CS	hf = 2.5E-7°Q^2	Section 3.7 of VYC-0808 Rev 6 (Ref: 4)			
	ner Losses (ft)						
1 RHF	R hs = 0.33	CS	hs = .38*(Q/4000)^2 for Q<= 4000	Section 3.6 of VYC-0808 Rev 6 (Ref: 4)			
Maximum D	ebris Losses (ft) O >= 173F						
1 RHF	R hd = 0.33	CS	hd = 0.21	See discussion in Section 4.2 of this CCN			
	ebris Losses (ft) @ < 173F						
1 RHF		CS	$hd = .21^{\circ}(173/T)$	See discussion in Section 2.0 of CCN04 (Ref. 11)			
Muele 1 = 2	suppression pool temperature, F						
Elevation H		-00	7 4057	See discussion in Section 4.2 of this CCN for conservatism.			
RHF	1 Z = 12.4	CS	Z = 12.57	500 discussion in Section 4.2 of this CCN for conservatism.			
NPSHr (ft)							
1 RHF	R NPSHr = 31.7	CS	NPSHr = 29.6	See discussion in Section 4.2 of this CCN			

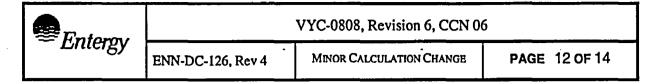


Table 4.2 LOCA - Long Term (1.5 wt. % Containment Leakage & 100% Spray Efficiency)

CS - Long Term (After EPU) 1.5 wt. % Containment Leakage & 100% Spray Efficiency

70 -011	9 101111	(Aiter El O)	110 114	/V 00111001			<u> </u>	<u></u>	Lincion	- /			
	GE Pool	GE Pool		_					CS	CS	CS		
Time	Temp	Pressure	Pg	Vf	z	hf	hs	hd	NPSHa	NPSHr	OPR	OPA	OPC
(sec)	(F)	psia	(psia)	(ft^3/lb)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(pslg)	(psig)	(psig)
786	169.7	17,71	5.951	0.016449	12.57	3.06	0.29	0.21	29.73	29.60	0.00	3.01	2.40
1,098	171.8	17.94	6.245	0.016461	12.57	3.06	0.29	0.21	29.05	29.60	0.23	3.24	2.40
2,033	176.6	18.57	6.962	0.016489	12.57	3.06	0.29	0.21	27.38	29.60	0.94	3.87	3.40
2,962	180.0	19.17	7.511	0.016509	12.57	3.06	0.29	0.21	26.10	29.60	1.47	4.47	3.40
4,196	183.4	19.90	8.096	0.016530	12.57	3.08	0.29	0.21	24.73	29.60	2.05	5.20	4.40
5,125	185.2	20.34	8.420	0.016541	12.57	3.06	0.29	0.21	23.96	29.60	2.37	5.64	4.40
6,275	187.0	20.82	8.756	0.016552	12.57	3.06	0.29	0.21	23.17	29.60	2.70	6.12	5.10
8,036	189.1	21.50	9,161	0.016566	12.57	3.06	0.29	0.21	22.22	29.60	3.09	6.80	5.10
10,220	191.0	21.86	9.541	0.016578	12.57	3.06	0.29	0.21	21.32	29.60	3.47	7.16	6.10
12,094	192.2	22.06	9.788	0.016585	12.57	3.06	0.29	0.21	20.74	29.60	3.71	7.36	6.10
15,170	193.6	22.31	10.083	0.016594	12.57	3.06	0.29	0.21	20.04	29.60	4.00	7.61	6.10
17,669	194.3	22.43	10.233	0.016599	12.57	3.06_	0.29	0.21	19.68	29.60	4.15	7.73	6.10
20,156	194.6	22.46	10.298	0.016601	12.57	3.06	0.29	0.21	19.53	29.60	4.21	7.76	6.10
23,812	194.7	22.48	10.320	0.016601	12.57	3.06	0.29	0.21	19.48	29.60	4.23	7.78	6.10
24,495	194.7	22.48	10.320	0.016601	12.57	3.06	0.29	0.21	19.48	29.60	4.23	7.78	6.10
25,120	194.7	22.47	10.320	0.016601	12.57	3.06	0.29	0.21	19.48	29.60	4.23	7.77	6.10
30,095	194.3	22.42	10.233	0.016599	12.57	3.06	0.29	0.21	19.68	29.60	4.15	7.72	6,10
35,065	193.7	22.33	10.104	0.016595	12.57	3.06	0.29	0.21	19.99	29.60	4.02	7.63	6.10
40,020	192.8	22.20	9,914	0.016589	12.57	3.06	0.29	0.21	20.44	29.60	3.83	7.50	5.60
45,637	191.5	22.01	9.644	0.016581	12.57	3.06	0.29	0.21	21.08	29.60	3.57	7.31	5.60
49,406	190.4	21.78	9.420	0.016574	12.57	3.06	0.29	0.21	21.61	29.60	3.35	7.08	5.60
60,551	187.2	21.21	8.794	0.018554	12.57	3.06	0.29	0.21	23.09	29.60	2.73	8.51	4.60
70,342	184.4	20.72	8.275	0.016536	12.57	3.06	0.29	0.21	24.31	29.60	2.22	6.02	4.10
80,342	181.8	20.28	7.816	0.016520	12.57	3.06	0.29	0.21	25.38	29.60	1.77	5.58	3.60
90,340	179.3	19.89	7.395	0.016505	12.57	3.06	0.29	0.21	26.37	29.60	1.36	5.19	3.10
100,340	176.8	19.52	6.994	0.016490	12.57	3.06	0.29	0.21	27.30	29.60	0.97	4.82	3.10
110,340	174.8	19.20	6.686	0.016478	12.57	3.06	0.29	0.21	28.02	29.60	0.66	4.50	2.60
120,306	173.2	18.93	6.447	0.016469	12.57	3.06	0.29	0.21	28.58	29.60	0.43	4.23	2.60
130,302	171.8	18.69	8.245	0.016461	12.57	3.06	0.29	0.21	29.05	29.60	0.23	3.99	2,10
140,302	170.4	18.47	6.048	0.015453	12.57	3.06	0.29	0.21	29.51	29.60	0.04	3.77	2.10
150,302	169.1	18.27	5.870	0.016445	12.57	3.06	0.29	0.21	29.92	29.60	0.00	3.57	1.70
160,302	167.8	18.07	5.696	0.016438	12.57	3.06	0.29	0.22	30.31	29.60	0.00	3.37	1.70
170,302	168.6	17.90	5.539	0.016431	12.57	3.06	0.29	0.22	30.67	29.60	0.00	3.20	1.30
180,302	165.3	17.72	5.374	0.018424	12.57	3.06	0.29	0.22	31.05	29.60	0.00	3.02	1.30
190,302	164.1	17.54	5.225	0.016417	12.57	3.06	0.29	0.22	31.40	29.60	0.00	2.84	1.30
194,052	163.6	17.47	5.164	0.016414	12.57	3.06	0.29	0.22	31.54	29.60	0.00	2.77	1.30
196,552	163.3	17.43	5.127	0.016413	12.57	3.06	0.29	0.22	31.62	29.60	0.00	2.73	1.30
197,802	163.2	17.41	5.115	0.016412	12.57	3.06	0.29	0.22_	31.65	29.60	0.00	2.71	1.30
200,302	162.9	17.37	5.079	0.016411	12.57	3.06	0.29	0.22	31.73	29.60	0.00	2.67	0.00

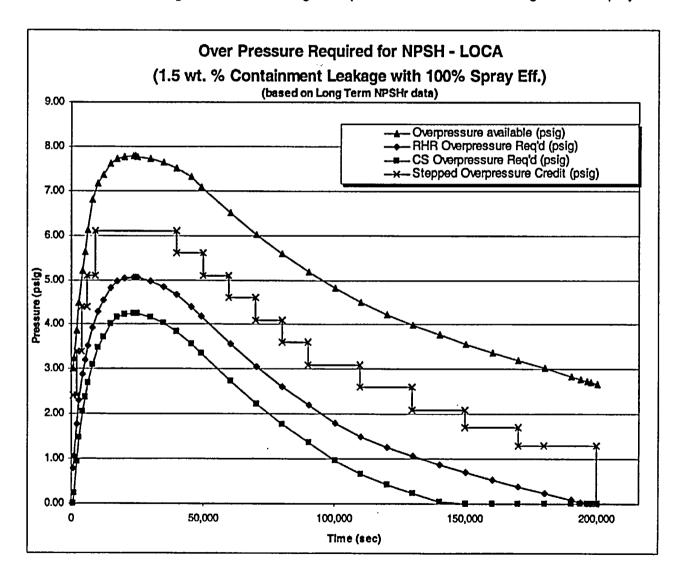
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≈ Entergy	ENN-DC-126, Rev 4	Minor Calculation Change	PAGE 13 OF 14					

Table 4.2 - LOCA - Long Term (1.5 wt. % Containment Leakage & 100% Spray Efficiency)
RHR - Long Term (After EPU) 1.5 wt. % Containment Leakage & 100% Spray Efficiency

HUH - FC		(After EPU	1.5 W	. % Cont	amment	Leakay	e & 100	76 Spra					·
	GE Pool	GE Pool			_			ا ا	RHR	RHR	RHR		
Time	Temp	Pressure	Pg	Vf	Z	hf	hs	hď	NPSHa	NPSHr	OPR	OPA	OPC
(sec)	(F)	psia	(psia)	(ft^3/1b)	(ft)	(ft)	(ft)	(11)	(ft)	(ft)	(psig)	(psig)	(psig)
786	169.7	17.71	5.951	0.016449	12.40	2.61	0.33	0.34	29.84	31.70	0.78	3.01	2.40
1,098	171.8	17.94	6.245	0.016461	12.40	2.61	0.33	0.33_	29.17	31.70	1.07	3.24	2.40
2,033	176.6	18.57	6.962	0.016489	12.40	2.61	0.33	0.33	27.50	31.70	1.77	3.87	3.40
2,962	180.0	19.17	7.511	0.016509	12.40	2.61	0.33	0.33	26.22	31,70	2.31	4.47	3.40
4,196	183.4	19.90	8.096	0.016530	12.40	2.61	0.33	0.33	24.85	31.70	2.88	5.20	4.40
5,125	185.2	20.34	8.420	0.016541	12.40	2.61	0.33	0.33	24.09	31.70	3.20	5.64	4.40
6,275	187.0	20.82	8.756	0.016552	12.40	2.61	0.33	0.33	23.30	31.70	3.53	6.12	5.10
8,036	189.1	21.50	9.161	0.016566	12.40	2.61	0.33	0.33	22.34	31.70	3.92	6.80	5.10
10,220	191.0	21.86	9.541	0.016578	12.40	2.61	0.33	0.33	21.44	31.70	4.30	7.16	6.10
12,094	192.2	22.06	9.788	0.016585	12.40	2.61	0.33	0.33	20.86	31.70	4.54	7.36	6.10
15,170	193.6	22.31	10.083	0.016594	12.40	2.61	0.33	0.33	20.16	31.70	4.83	7.61	6.10
17,669	194.3	22.43	10.233	0.016599	12.40	2.61	0.33	0.33	19.81	31.70	4.98	7.73	6.10
20,158	194.6	22.46	10.298	0.016601	12.40	2.61	0.33	0.33	19.65	31.70	5.04	7.76	6.10
23,812	194.7	22.48	10.320	0.016601	12.40	2.61	0.33	0.33	19.60	31.70	5.06	7.78	6.10
24,495	194.7	22.48	10.320	0.016601	12.40	2.61	0.33	0.33	19.60	31.70	5.06	7.78	6.10
25,120_	194.7	22.47	10.320	0.016601	12.40	2.61	0.33	0.33	19.60	31.70	5.06	7.77	6.10
30,095	194.3	22.42	10.233	0.016599	12.40	2.61_	_ 0.33_	0.33	19.81	31.70	4.98	7.72	6,10
35,065	193.7	22.33	10.104	0.016595	12.40	2.61	0.33	0.33	20,11	31.70	4.85_	7.63	6.10
40,020	192.8	22.20	9.914	0.016589	12.40	2.61	0.33	0.33	20.58	31.70	4.66	7.50	5.60
45,637	191.5	22.01	9.644	0.016581	12.40	2.61	0.33	0.33	21.20	31.70	4.40	7.31_	5.60
49,406	190.4	21.78	9.420	0.016574	12.40	2.61	0.33	0.33	21.73	31.70	4.18	7.08	5.60
60,551	187.2	21.21	8.794	0.016554	12.40	2.61	0.33	0.33	23.21	31.70	3.56	6.51	4.60
70,342	184.4	20.72	8.275	0.016536	12.40	2.61	0.33	0.33	24.43	31.70	3.05	6.02	4.10
80,342	181.8	20.28	7.816	0.016520	12.40	2.61	0.33	0.33	25.50	31.70	2.60	5.58	3.60
90,340	179.3	19.89	7.395	0.016505	12.40	2.61	0.33	0.33	26.49	31,70	2.19	5.19	3.10
100,340	176.8	19.52	6.994	0.016490	12.40	2.61	0.33	0.33	27.43	31.70	1.80	4.82	3.10
110,340	174.8	19.20	6.686	0.016478	12.40	2.61	0.33	0.33	28.14	31.70	1.50	4.50	2.60
120,306	173.2	18.93	6.447	0.016469	12.40	2.61	0.33	0.33	28.70	31.70	1.26	4.23	2.60
130,302	171.8	18.69	6.245	0.016461	12.40	2.61	0.33	0.33	29.17	31.70	1.07	3.99	2.10
140,302	170.4	18.47	6.048	0.016453	12.40	2.61	0.33	0.34	29.62	31.70	0.88	3.77	2.10
150,302	169.1	18.27	5.870	0.016445	12.40	2.61	0.33	0.34	30.03	31.70	0.71	3.57	1.70
160,302	167.8	18.07	5.696	0.016438	12.40	2.61	0.33	0.34	30.43	31.70	0.54	3.37	1.70
170,302	166.6	17.90	5.539	0.016431	12.40	2.61	0.33	0.34	30.79	31.70		3.02	
180,302	165.3 164.1	17.72 17,54	5.374 5.225	0.016424	12.40	2.61 2.61	0.33	0.35	31,16 31.51	31.70 31.70	0.23	2.84	1.30
190,302 194,052	163.6	17,54	5.164	0.016417	12.40	2.61	0.33	0.35	31.65	31.70	0.02	2.77	1.30
196,552	163.8	17.47	5.104	0.016414	12.40	2.61	0.33	0.35	31.73	31.70	0.02	2.73	1.30
197,802	163.2	17.41	5.115	0.016412	12.40	2.61	0.33	0.35	31.76	31.70	0.00	2.71	1.30
200,302	162.9	17.37	5.079	0.016411	12.40	2.61	0.33	0.35	31.84	31.70	0.00	2.67	0.00
200,002	102.0	17.07	3.013	0.010411	16.70	201	1 0.00	0.00	01.07	, 01170	0.00		<u> </u>

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**Entergy	ENN-DC-126, Rev 4	MINOR CALCULATION CHANGE	PAGE 14 OF 14					

Figure 4.2 LOCA - Long Term (1.5 wt. % Containment Leakage & 100% Spray Efficiency)



0	PC
overpre	ss credit
(sec)	(psig)
601	2.4
2000	2.4
2001	3.4
4000	3.4
4001	4.4
6000	4.4
6001	5.1
9000	5.1
9001	6.1
40000	6.1
40001	5.6
50000	5.6
50001	5.1
60000	5.1
60001	4.6
70000	4.6
70001	4.1
80000	4.1
80001	3.6
90000	3.6
90001	3.1
110000	3.1
110001	2.6
130000	2.6
130001	2.1
150000	2.1
150001	1.7
170000	1.7
170001	1.3
180000	1.3
200000	1.3
200001	0



VYC-0808, Revision 6, CCN 06, Attachment A

ENN-DC-126, Rev 4

MINOR CALCULATION CHANGE

PAGE 1 OF 6

Excel Verification Sample Calculation

Table 4.1 CS Verification (Line 40):

Cell G40 =
$$$F$30$$

= 12.47

Cell M40 =IF((+L40-K40)/(144*F40)>0,(+L40-K40)/(144*F40),0) =
$$(28.00-28.44)/(144*0.016423) = -0.186<0$$
, False = 0



VYC-0808, Revision 6, CCN 06, Attachment A

ENN-DC-126, Rev 4

MINOR CALCULATION CHANGE

PAGE 20F6

Table 4.2 CS Table Verification (Line 50):

```
Cell F50 = F$25
         = 12.57
Cell G50 = 0.00000025*$F$9^2
         = 0.00000025*3500^2
         = 3.06
Cell H50 = 0.38*(($F$9/4000)^2)
         = 0.38*((3500/4000)^2)
         = 0.29
Cell I50 = ROUND(IF(B50<173,\$F\$18*(173/B50),\$F\$18),2)
         194.3<173 = False (For True outcome see below, Cell I72)
         = F$18
         = 0.21
         Cell I72
                    = ROUND(IF(B72<173,\$F\$18*(173/B72),\$F\$18),2)
                    = 162.9 < 173 = True
                    = F$18*(173/B72)
                    = 0.21*(173/162.9)
                    = 0.22
Cell J50 = +((14.7-D50)*144*E50)+F50-G50-H50-I50
         =((14.7-10.233)*144*0.016599)+12.57-3.06-0.29-0.21
         = 19.687 [Worksheet shows 19.68 - Check OK - difference attributed to significant
                    figures used in hand calc vs Excel]
Cell K50 = F$28
         = 29.6
Cell L50 = IF((+K50-J50)/(144*E50)>0,(+K50-J50)/(144*E50),0)
         (29.6-19.68)/(144*0.016599) = 4.15>0 True (For False outcome see below, Cell L34)
         =4.15
         Cell L34
                    = IF((+K34-J34)/(144*E34)>0,(+K34-J34)/(144*E34),0).
                    = (29.6-29.73)/(144*0.016449) = -0.055>0 False
Cell M50 = +C50-14.7
         =22.42-14.7
         =7.72
```



VYC-0808, Revision 6, CCN 06, Attachment A

ENN-DC-126, Rev 4

MINOR CALCULATION CHANGE

PAGE 3 OF 6

Table 4.2 RHR Table Verification (Line 78):

```
Cell F78 = C$25
         = 12.40
Cell G78 = 0.0000000477*$C$9^2
         = 0.0000000477*7400^2
         = 2.61
Cell H78 = C$15
         = 0.33
Cell I78 = ROUND(IF(B78<173,$C$18*(173/B78),$C$18),2)
         169.7<173 = True (For False outcome see below, Cell I81)
         = C$18*(173/B78)
         = 0.33*(173/169.7)
         = 0.34
                    = ROUND(IF(B81<173,$C$18*(173/B81),$C$18),2)
         Cell I81
                    180<173 = False
                    = C$18
                    = 0.33
Cell J78 = +((14.7-D78)*144*E78)+F78-G78-H78-I78
         =((14.7-5.951)*144*0.016449)+12.40-2.61-0.33-0.34
         = 29.84
Cell K78 = C$28
         = 31.7
Cell L78 = IF((+K78-J78)/(144*E78)>0,(+K78-J78)/(144*E78),0)
         (31.7-29.84)/(144*0.016449)=0.785>0 True (For False outcome see below, Cell L116)
         = 0.785
                           [Worksheet shows 0.78 - Check OK - difference attributed to
                           significant figures used in hand calc vs Excel]
         Cell L116 = IF((+K116-J116)/(144*E116)>0,(+K116-J116)/(144*E116),0)
                    = (31.7-31.84)/(144*0.016411) = -0.059>0 False
                    =0
Cell M78 = +C78-14.7
         = 17.71-14.7
         = 3.01
```

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								See despates in Section 4.7 of this CCD4							
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	HER	NP94 -	216												
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A													
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VY CALCULATION DATABASE INPUT FORM

Attachment B Page 1 of 2

Place this form in the calculation package immediately following the Title page or CCN form.

VYC	-0808 / 06 _		6N/AN/A			
VY Calculation	n/CCN Number	Revision	Number Vendor Calculation Number Revision Numb	er		
Vendor Name	N/A	PO Num	ber: N/A			
Originating De	partment: Fluid Sy	stems				
Critical Refere	ences Impacted: 🛛 U	FSAR 2	DBD Reload. "Check" the appropriate box if any critical document is in	lentified in the tab	les below.	
EMPAC Asse	Equipment ID Numl	ber(s):	P-10-1A/B/C/D, P-46-1A/B			
EMPAC Asset	/System ID Number(s):	10, 14			
Keywords: <u>I</u> (EPU)	Residual Heat Remov	al (RHR)	Core Spray (CS), Net Positive Suction Head (NPSH), Loss of Coolant Accide	nt (LOCA), Exten	ded Power Upra	ate
Design Input	•	ieral Ref	eneral References, Design Input Documents or Design Output Documents requerences - The following documents provide design input or supporting informations.			
*				Significant	***	Critical
Referenc		REV		Difference	Affected	Reference
e#	** DOC#	#	***Document Title (including Date, if applicable)	Review ††	Program	(√)
t	GE-VYNPS-AEP-346	1	VYNPS EPU T0400: DBA-LOCA for Long Term NPSH evaluation (7/6/04)			
2	VYC-1924	0	DE&S Calc. DC-A34600-006. Vermont Yankee ECCS Suction Strainer Head Loss Performance Assessment, RHR and CS Debris Head Loss Calculations			
3	VYC-0808 / CCN 03	6	Core Spray and Residual Heat Removal Pump Net Positive Suction Head Margin Following a Loss of Coolant Accident			
4	VYC-0808	6	Core Spray and Residual Heat Removal Pump Net Positive Suction Head Margin Following a Loss of Coolant Accident			
5	ERC-2004-024	N/A	Revised OPL-4 Input for Minimum DW Pressure Case dated 6/8/04			
6			NOT USED			
7			ASME Steam Tables, 1967 IFC Formulation for Industrial Use			
8	ERC No. 2003-027	N/A	Debris Source Terms Appropriate for Power Uprate Evaluations of ECCS NPSH (5/13/03)			

DE&S Calc. DC-A34600-006. Vermont Yankee ECCS Suction Strainer Head Loss Performance

Core Spray and Residual Heat Removal Pump Net Positive Suction Head Margin Following a Loss of Coolant Accident or Anticipated Transients Without Scram

Core Spray and Residual Heat Removal Pump Net Positive Suction Head Margin Following a Loss of Coolant Accident or Anticipated Transients Without Scram

Design Basis Document for Residual Heat Removal System

Assessment, RHR and CS Debris Head Loss Calculations

9

10

11

12

RHR

VYC-1924 / CCN 02

VYC-0808 / CCN 04

VYC-0808 / CCN 05

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✓

VYC-0808 Revision 6 CCN #6 Attachment B

				Page 2 of 2	4
* Reference #	** DOC #	REV #	Document Title (including Date, if applicable)	**** Affected Program	†††Critical Reference (✓)
12	NEDC-33090P	0	Safety Analysis Report For VYNPS Constant Pressure Power Uprate (PUSAR)		
13	VYC-1628	0	Torus Temperature and Pressure Response to Large Break LOCA and MSLB Accident Scenarios (may be superseded be GE EPU analysis)		
14	SADBD	2/IC2	Topical Design Basis Document for Safety Analysis		✓
15	UFSAR	17	Updated Final Safety Analysis Report		✓
16	RHR	1/IC16	Design Basis Document for Residual Heat Removal System		√
17	CS	0/IC10	Design Basis Document for Core Spray System		✓
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ll		<u> </u>			<u> </u>

* Reference # -	Assigned by preparer to identify the reference in the body of the calculation.
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** Doc # - Identifying number on the document, if any (e.g., 5920-0264, G191172, VYC-1286)

*** Document Title - List the specific documentation in this column. "See attached list" is not acceptable. Design Input/Output Documents should identify the specific design input document used in the calculation or the specific document affected by the calculation and not simply reference the document (e.g., VYDC, MM) that the calculation was written to support. If a DBD is used as a general reference, include the most current interim change number after the title.

**** Affected List the affected program or the program that reference is related to or part of.

Program -

† If "yes," attach a copy of "VY Calculation Data" marked-up to reflect deletion (See Section 3.1.8 for Revision and 5.2.3.18 for CCNs).

If the listed input is a calculation listed in the calculation database that is not a calculation of record (see definition), place a check mark in this space to indicate completion of the required significant difference review. (see Appendix A, section 4.1.4.4.3). Otherwise, enter "N/A."

If the reference is UFSAR, DBD or Reload (IASD or OPL), check Critical Reference column and check UFSAR,

DBD or Reload, as appropriate, on this form (above).

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